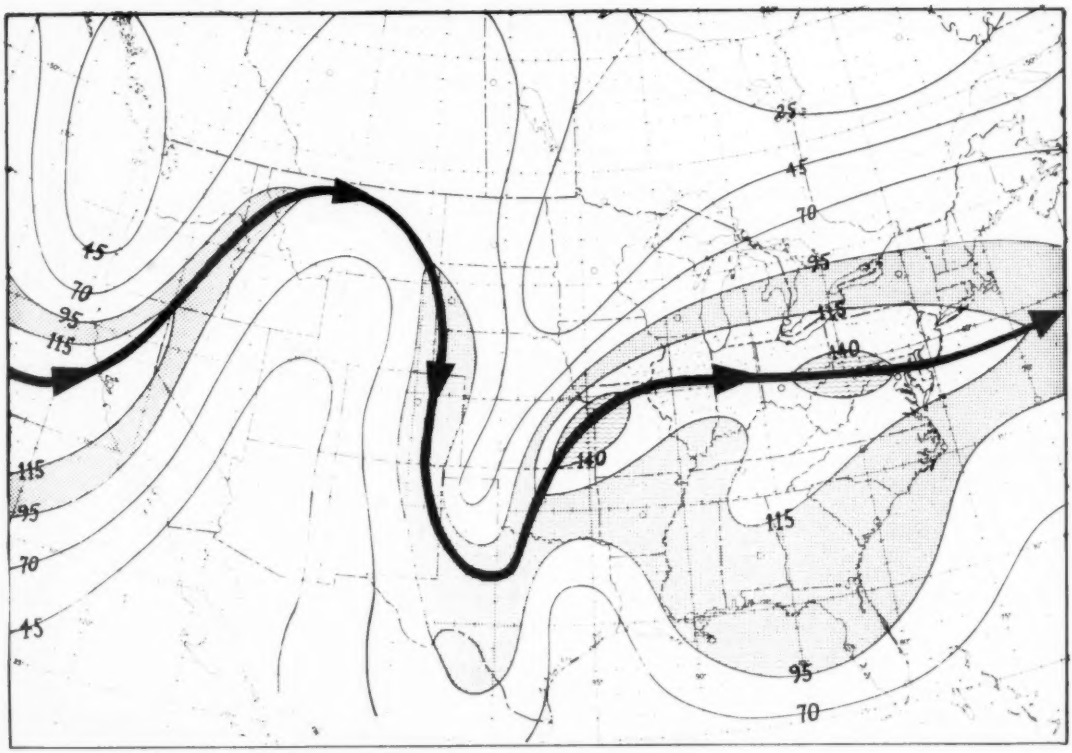
Weatherwise



A Jet Stream Weather Chart

Volume 7 Number 1 February 1954

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

DAVID M. LUDLUM, *Editor* HENRY W. BULKLEY, *Associate Editor*

A Correction

Editor:

We have noted with interest the article "Flying the Weather Map With the Wright Brothers" that appeared in the December issue of WEATHERWISE. In this connection I should like to point out that we apparently made a mistake in assuming that the 'on-the-spot' description of the first flight came from the weather observer at Kitty Hawk, as stated in the first paragraph of this article.

An early Wright Brothers "press release" describing their first flight has recently come to our attention. This description so nearly paralleled that given in our daily weather map-back article "Beginnings of Aviation Weather Service," released March 31, 1953, and the Monthly Weather Review of December 1903 from which we quoted in this article that we checked further into the source of the Monthly Weather Review article. It now appears that the Monthly Weather Review article should not have been accredited to the Weather Bureau observer at Kitty Hawk, but it is more likely that it was an account of the flight composed by the Editor of the Monthly Weather Review, using the Wright Brothers' story as part of the source material. I thought you would be interested in the clarification of this point.

Sincerely,

I. R. TANNEHILL, *Chief*
Division of Synoptic Reports and Forecasts

Vol. 7, No. 1 February, 1954

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Cover: The chart shows the position of the Jet Stream (wide arrow) at the 300 mb level (approx. 30,000 feet) at 1000 EST, 30 December 1952. Thin lines are of equal wind speed in mph. A Navy jet probed this Jet Stream and encountered winds up to 180 mph and temperatures as low at −64° F.

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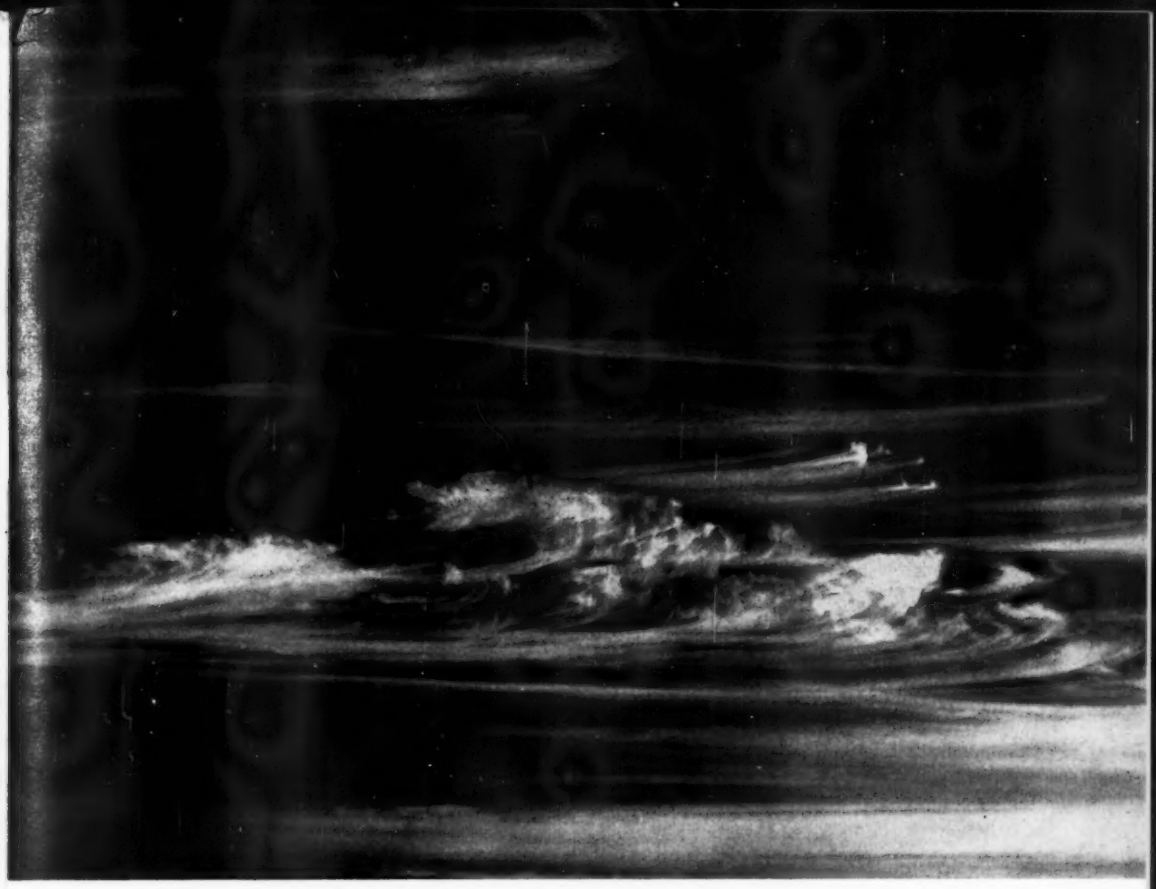


Jet Stream cirrus clouds photographed at 1700 EST, 2 March 1953, at Schenectady, N. Y., by Dr. Vincent Schaefer.

Jet Stream Research in the Navy

COMMANDER EDWIN T. HARDING, *U. S. Navy*
Assistant Officer in Charge, Project AROWA

THE Jet Stream has recently become a "best seller" topic among both scientific and popular writers. Despite frequent stories of aircraft flying at one to two times the speed of sound, of atomic marvels to come, of the feats of science fiction characters, adults, at least, are still close enough to reality and to the feel of a windy day to be astounded by the thought that we often have a 200–300 mph river of air flowing overhead. The Navy is impressed, too, but it has a special interest in reaching a precise understanding as to what the Jet Stream really is—to learn how to forecast it and how to judge its military significance.

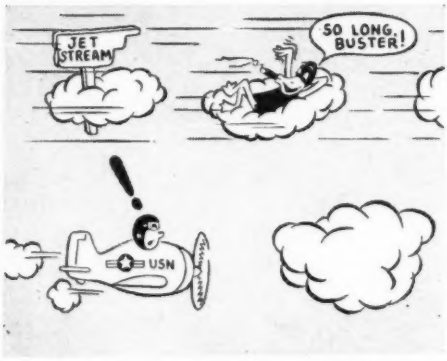
We already know much, and are rapidly learning more, about the close connection between the Jet Stream and weather developments at lower levels. This knowledge is operationally important, but potentially more important problems remain to be solved. First, aircraft design must take into account the operational and structural hazards of clear-air turbulence found in and around the Jet Stream. Next, we must learn how to use the Jet Stream on a planned basis so as to "wring" the most in performance from our aircraft. The problem steadily grows more acute, because with each increase in the speed of planes there is a corresponding increase in

fuel consumption—some experimental models carry only enough fuel for three to four minutes; even operational fighters are considerably limited in combat radius by their ability to carry fuel.

A Navy Task Force should be visualized as a huge, mobile, self-sustaining military airfield. With the ability to move several hundred miles a day, such a force can locate itself so as to combine nearness to enemy targets with the most favorable weather situation. This was done many times during World War II, and more recently in the Korean area. What factors, then, are of importance in the Jet Stream? Task Force bombers must reach the target and return; in some cases they will require fighter protection. Availability of high-speed tail winds for half the run will increase the number of available targets and add much to the safety and flexibility of the operation. The fastest fighters, hence those with the shortest range, could be held aboard to protect against enemy attack. With the Jet Stream advantageously located, these fighters could use it to perform their interception mission well away and downstream from the Task Force. It is apparent then that a key naval operation could be disrupted by ignoring the Jet Stream; conversely, judicious use of "God's Extra Engine" might insure success. All this is why the Navy has been and will be vitally concerned with research in the Jet Stream field.

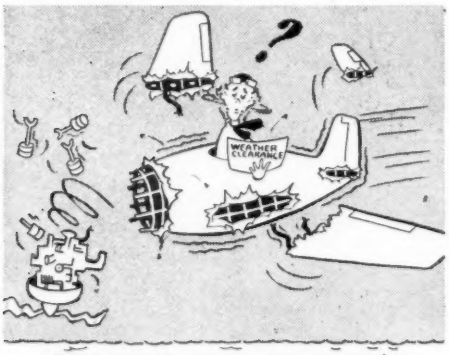
While Professor Willett of Massachusetts Institute of Technology had demonstrated the existence of high-speed winds in a narrow band in the general circulation and these winds had been observed many times by Air Force bombers over Japan in 1943–45, it was not until 1946 that the Jet Stream was fully recognized and defined as a meteorological entity. This came as an outgrowth of a University of Chicago general circulation study, sponsored by the Office of Naval Research. Since that time much study has been devoted to the problem in this country by men such as Rossby, Riehl, Namias, Cressman, Palmén, and their associates.

To further research of an applied nature on the Jet Stream, the U. S. Navy in 1950 decided to center its work in this direction at Project AROWA (Applied Research; Operational Weather Analyses—a Bureau of Aeronautics research project). A preliminary review of the literature showed that the fundamental concepts were often unrelated or even conflicting and that pertinent scientific articles were scattered through a great many periodicals and unpublished manuscripts. The first and obvious step was to establish a firm jumping-off-place for further research. A contract was made with the University of Chicago. This provided for a thorough review and evaluation of Jet Stream literature, an investigation and testing of forecasting techniques, and for development of new information on the Jet Stream by detailed upper-air analyses. The outcome was a Project AROWA publication, "The Jet Stream," which summarizes and evaluates all applicable information up to 1953. Distribution of this publication has been primarily limited to the military services, but it is presently under consideration for distribution as an American Meteorological Society monograph.



The study described above pointed to the fact that fairly sound theories and some rough forecasting techniques on the Jet Stream could be developed by use of upper-air data over the United States; but, because of the relatively coarse network of reporting stations and the narrowness of the Jet Stream, the fine structure could not be described. Measurement by aircraft under controlled conditions was the only solution, since commercial flights on a set track and not properly instrumented would provide only fragmentary information. The Navy turned to two sources. To study the Pacific area,

an AROWA contract was negotiated with Pan American World Airways. Using past data from regular reporting stations and earlier Stratocruiser flights, along with data from current flights, a general concept of the Pacific Jet Stream was developed. From this a preliminary forecasting method evolved. When testing of this technique on some of the 1952–53 flights proved consistently successful, the whole pattern of west–east flights for the 1953–54 winter season was adapted to take advantage of the Pacific Jet. Six regular flights per week in the Jet Stream



"STAY OUT OF THE CLOUDS AND YOU'LL ENCOUNTER NO TURBULENCE."

are scheduled for this year with special observations taken at ten minute intervals. Vortex thermometers have been provided by the Navy to obtain more accurate temperature readings. Case studies are in progress to fit the four general synoptic types presently envisaged as covering the needs of a forecaster. These studies, which will include some new forecasting techniques, should be completed by July 1954. The documentation, in addition to the data from the Stratocruiser flights and regular reporting stations, will include in-flight observations and forecasting results from two years' work with British Comet flights between Tokyo and southeast Asia. The final outcome of this research will be a Navy Forecasting Manual for the Pacific area which, if possible, will be coordinated with data from the United States project to make a generalized Jet Stream Forecasting Manual.

The other, and more important, approach adopted by the Navy is an attempt to obtain accurate measurements of various Jet Stream elements by use of carefully controlled and instrumented jet aircraft. For this purpose two jet fighters are assigned to Project AROWA. These planes are instrumented so as to provide 11-second-interval photographic records of position, height, heading, speed, temperature, and turbulence. The turbulence recorders are provided by the National Advisory Committee for Aeronautics, which is principally concerned with the problem of clear-air turbulence. Up to now the Navy's probing flights are the only source of continuous, controlled measurements of the phenomenon in this country. By the time aircraft were available for the 1952–53 winter season only twenty flights were possible, and the data from these are still being processed.

The Bureau of Aeronautics has assigned two new Skyknight jet fighters for the 1953–54 season in order to minimize mechanical failures. The probing flights will operate seven days per week, regardless of weather, whenever the Jet Stream is within reach geographically and is intense enough to justify a flight. Flights will be planned at Project AROWA in Norfolk and will cover any part of the eastern United States meeting the above requirements. The fighters will be based at Naval Air Station, Patuxent River, Maryland, and flown by personnel from the Naval Air Test Center. An attempt will be made to transit the Jet Stream with both aircraft, twice a day if possible. Heights will be varied and on some occa-

sions flights will be along the long axis of the Jet Stream.

A related Air Force group will make coordinated flights in some cases to provide additional observations. These data, along with those obtained last year, will be the first accurate and controlled measurements within the Jet and should open new horizons to forecasters, theoreticians, and the military services.

A Douglas Skynight F3D-1 jet night fighter which is used to probe the Jet Stream. Official U. S. Navy photo.

Col. Merewether Heads New AMS Slate

The election of Col. Arthur F. Merewether to the presidency of the American Meteorological Society for 1954–55 was announced at the annual business meeting in New York City on 28 January. Col. Merewether, a member of the AMS since 1935, brings a rich experience in both military and civilian activities to his new post. Since his retirement from the Air Force in 1946, he has been supervisor of meteorology for American Airlines.

Dr. Harry Wexler, USWB, Washington, was elected to the vice-presidency. Five new councilors were named for three year terms: Dr. Henry Houghton, MIT; Brig. Gen. Thomas Moorman, USAF; Dr. Morris Neiburger, UCLA; Daniel F. Rex, USN; R. C. Schmidt, USWB, Washington; and Rev. Thomas B. Macelwaine, St. Louis Univ. (to serve out term vacated by Col. Merewether).

Florida Freezes

WARREN O. JOHNSON, *U. S. Weather Bureau, Lakeland, Fla.*

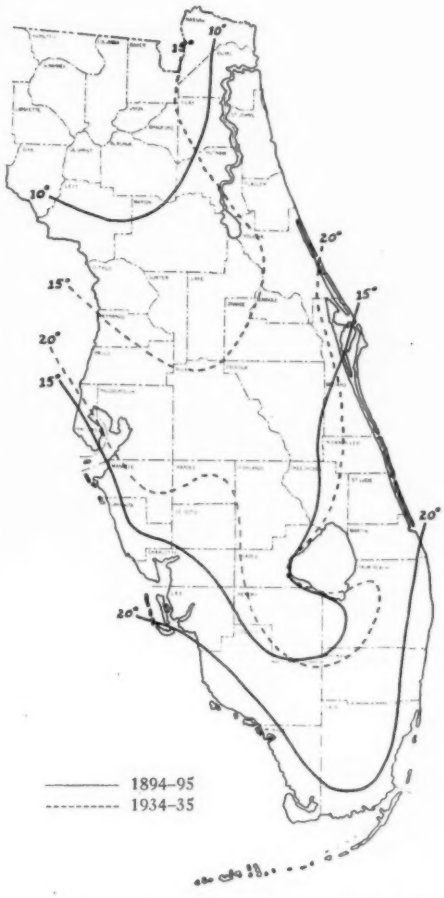
THE peninsula of Florida, in addition to being the southernmost land in the United States, is washed by the warm waters of two tropical seas. Most of the state is of relatively low elevation and without natural barriers. Proximity to warm air sources and distance from cold air regions are prime factors in the climatology of the Sunshine State. Yet, major cold spells do occasionally overspread the entire peninsula and cause severe damage to nearly all varieties of fruits and vegetables grown during the winter months. Though the tourist trade is the largest individual industry of the state, the infrequent cold spells, while being of some discomfort to northern visitors, do not materially affect that billion dollar bonanza; but the freezes, on occasion, have been very detrimental to the agricultural industry.

The severity of a freeze is based not only on the degree of the minimum temperatures reached, but also is influenced by the time of the growing season, the duration of low temperatures, and the resultant damage. The microclimatic temperature records of more than 400 survey stations operated during the winter season in peninsular Florida's fields and groves by the Federal-State Frost Warning Service have been a helpful factor in selecting the most favorable acreage locations and times of planting for the various crops. This program has done much to reduce the yearly losses; and many freezes of the past which were classified major in amount of damage had higher general minima than freezes of today which are classified as minor.

Florida freezes affect different crops in different ways. A freeze that may be classified as severe by truck crop growers may at the same time be highly beneficial to citrus. Citrus will withstand temperatures as low as 28° F. for as long as two hours without damage and even derive considerable benefit, as cold weather enhances the coloring of the fruit and aids in sweetening it. Tender truck crops, on the other hand, will be severely damaged or completely killed by frost even though the air temperature may be no lower than 32–36°.

THE CITRUS INDUSTRY

Historical records indicate that cold waves damaged citrus in Florida in 1835 and 1857; both years were severe winters in the North. Systematic weather records were begun in the 1880's and were soon expanded; from 1887 to date reliable records are available. Severe freezes were experienced in January 1886,



Minimum temperatures at colder locations in the two outstanding Florida freezes. Since the coverage of reports was not complete in 1894–95, some interpolation was necessary. Courtesy of Florida Federal-State Frost Warning Service.

A rare snow scene at Daytona Beach, Florida, on 3 February 1951 when two inches fell at St. Augustine. The record snowstorm for all Florida is 2.1 inches at Pensacola, 12–13 February 1899. U. S. Weather Bureau photo.

December 1894, February 1895, and February 1899. The most destructive was the combination of the December and February freezes of the 1894–95 season.

In the season prior to 1894–95 approximately five million boxes of citrus were produced in Florida with the major producing area located in the northern portion of the state. The season of 1895–96 saw only 150,000 boxes of fruit harvested, meaning a 97 per cent reduction in production due to the 1894–95 freezes. It may be well to analyze this catastrophe since it dealt the citrus industry such a major blow. Temperatures dropped to a low of 12–16° in north Florida and 17–21° in central Florida during the period of 28–30 December 1894. Much of the fruit was frozen and considerable wood damage occurred; the majority of groves, however, survived and made a good recovery, and heavy new growth appeared in a normal January and early February. The new growth and sap-flowing trees were again either severely damaged or killed on 9–10 February 1895 when temperatures dropped to a low of 15–19° in north Florida and 17–21° in central Florida.

After examining the weather records and the production of citrus for all freezes, it becomes clear that the combination of an early freeze in November or December, which is followed by a month or longer of warm weather and then by a freeze in February, will do the greatest damage. In February 1899, temperatures were even lower than those experienced in the 1894–95 freeze: Tallahassee − 2°, Gainesville 6°; but the damage in proportion was not as great as the "one-two punch" of 1894–95. In spite of the fact that the citrus had moved further south, the additional damage of the 1899 freeze was of such a nature as to discourage the citrus growers, and it was not until a decade later, the 1909–1910 season, that citrus production again reached the five million box mark.

A slight setback to the industry again occurred 2–6 February 1917 when temperatures dropped to 15–20° in north Florida and 20–25° in central Florida. Although the temperatures were rather low and much fruit was lost, the permanent damage to the mature trees was not excessive.

The next 11 seasons were fairly favorable with only an occasional minor cold spell. On 3–4 January 1928, however, temperatures again dropped low enough to cause some general, but not serious, harm to citrus. Considerable damage took place on 12–13 December 1934 when temperatures of 16–24° were recorded in north and central Florida. Citrus trees put out an abundance of new growth as an aftermath of the shock of the December

freeze, encouraged by warm weather in late December and January, and were in a succulent condition by late February 1935 when a moderate cold spell occurred. Minimum temperatures during this February freeze were no lower than the mid-twenties, but damage to trees was rather severe as a result of their vulnerable condition. In the colder locations considerable grove acreage, which had survived the much lower temperatures of the December freeze and were recovering, was lost. This again brought out the death-dealing nature of the "one-two punch" type of freezes.

The Federal-State Frost Warning Service was established in 1935, and temperature survey stations set up in fields and groves that would give more accurate records as to the temperature actually experienced among the citrus trees. Heretofore, most of the temperature records were from locations that were not truly representative of grove conditions.

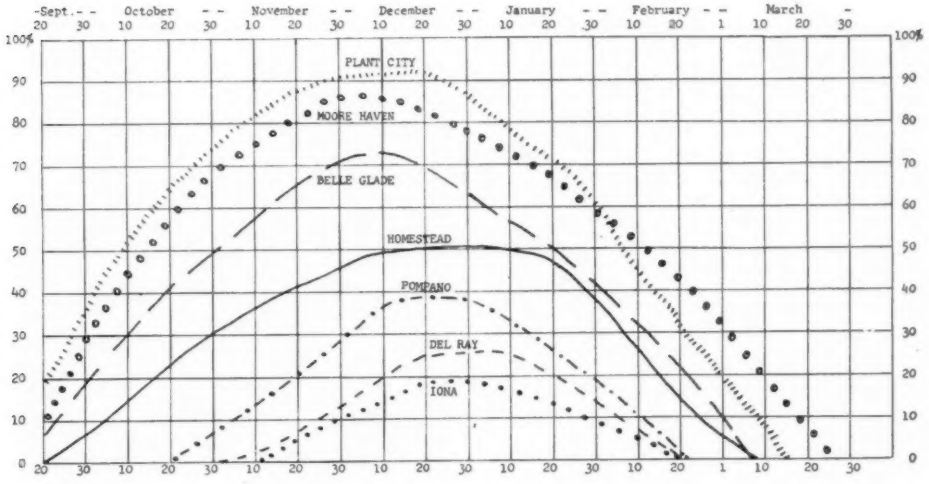
The period 25–29 January 1940 was very cold with the mercury dropping to 12–18° in north Florida and 14–20° in central Florida. Loss of unprotected citrus fruit was heavy and considerable damage occurred to wood, especially in the colder locations. Permanent damage was not extensive since favorable recovery weather prevailed during the remainder of the season. The 1940–41 season experienced unusually early and late freezes with readings below the critical point over the entire citrus belt on 16–17 November and again on 2–3 March. Some damage to citrus fruit occurred in November from the low temperatures, but readings in early March were generally in the mid-twenties and losses were slight since most of the fruit had either already been picked or had been destroyed in the November freeze.

In the past decade, moderately severe freezes, which damaged unprotected fruit and trees in the colder locations, occurred on: 15–16 January 1948; and 26–30 November 1950.

It is interesting to note that the frequency of the "one-two punch" type freeze is not very great, the noteworthy ones having occurred during the 1894–95 and 1934–35 seasons.

The Vegetable Industry

The winter vegetable industry in Florida has been constantly developing so that at the present time the total dollar return from vegetables and other winter non-citrus products, such as gladiolus, strawberries, and nursery



Graph shows the percentage of seasons in the past 16 years that a "60-day" crop at consecutive plantings experienced a temperature of freezing or below in the principal winter vegetable areas of Florida. For example: the hazard of having a freeze during a "60-day" crop planted on 10 October at Homestead would be about 12 per cent; by 10 December, 50 per cent.

plants, now almost equals the income of the rapidly expanding citrus industry. Incidentally, the Florida winter tomato crop and the grapefruit crop of the 1951–52 season produced an equal return of $51 million each. The greatest peril in the growing of tender crops in Florida is frost and freeze. This hazard, however, may be considered a blessing in disguise since so much land is available for winter farm operation that, if it were not for the frost and freeze hazard, the volume of production would be so tremendous that the market would be glutted with resultant low money returns to individuals.

The best type of soil for the growing of tender vegetables is the low ground muck soil, which is also the most subject to low temperatures and frost. The number of mornings with frost in Florida for the period of November through March has varied from as few as 23 in a single season to as many as 66. Climatological and synoptic stations, as a rule, do not give a true picture of the occurrences of frost and freezes in the winter farm areas of the state. Occasionally all of the synoptic stations in south and central Florida will report minima of 38° and higher when the vegetable industry has suffered a disastrous freeze. A recent example of this was during the winter of 1951–52 when the airport at West Palm Beach, which is considered an inland location, reported a temperature of 50°, but beanfields 10 to 20 miles to the west and south were severely damaged by frost with temperatures down to 31°.

Heavy vegetable freeze losses occurred during all of the freeze seasons mentioned in discussing the citrus industry. This does not mean, however, that the vegetable industry has a disastrous year during every season the "one crop a year" citrus industry suffers a severe freeze. Truck growers immediately start planting another crop after a freeze and financially may have a successful season in spite of one or two losses. Frost and freezes damaging to the tender crops occur in all areas of Florida every winter season, so we will not attempt to outline the freezes that have adversely affected the vegetable industry. The accompanying graph gives a good indication of the freeze hazard of the various areas of the state for 60-day crops. The Pompano and Iona areas have very limited acreage and are located near the coast, and Homestead is in the southernmost agricultural area of the state.

Frost damage to tender crops has occurred in northern Florida and the low ground locations of central Florida as early as 16 October and as late as 21 April. Scattered frost in the Everglades has come as late as mid-April. The longest mid-winter frost-free period of record occurred during the 1949–50 season. It was cold and frosty in November and most of December and from 17 February to mid-April 1950; but the period from 15 December to 16 February—53 days—was completely frost-free in all of peninsular Florida.

The vegetable grower is a hardy individual and can lose hundreds of acres of tender vegetables by a frost during the early morning hours and then start replanting the same day. In fact, there are a few growers who begin replanting their fields on a "freeze forecast" in order to get a new crop ready for market as early as possible.

Upon advanced warning young pepper plants were covered with dirt by plowing. Eighty per cent of crop was saved from frost damage; 10–20 per cent was lost in covering and uncovering.

The swearing-in ceremony of the civilian members of the Committee on Weather Control on 18 December 1953. From left to right: Kenneth C. Spengler, Joseph J. George, Lewis W. Douglas, A. M. Eberle, Howard T. Orville, and Hon. Luther W. Youngdahl.

Advisory Committee on Weather Control

THE Advisory Committee on Weather Control held its first meeting in Washington, D. C., on 18 December 1953, with all members present. The Committee was created pursuant to Public Law 256, 83d Congress, 1st Session, approved 13 August 1953. The civilian members of the Committee, who were appointed by President Eisenhower, are currently: Howard T. Orville, Capt. USN (ret.), Baltimore, Md., chairman; A. M. Eberle, Dean of Agriculture, South Dakota State College, Brookings, S. D., vice-chairman; Lewis W. Douglas, Sonoita, Ariz.; Joseph J. George, Supt. of Meteorology, Eastern Airlines, Atlanta, Ga.; Kenneth C. Spengler, Executive Secretary, AMS, Boston, Mass.

The Government representatives are: J. Earl Coke, Assistant Secretary of Agriculture; Alan T. Waterman, National Science Foundation; Earl G. Droessler, Dept. of Defense; Luna B. Leopold, Dept. of Interior; John Ludwig, Dept. of Health, Education, and Welfare; and Francis W. Reichelderfer, Dept. of Commerce.

The Committee has established offices at 1128, General Services Administration Building, 18th and F Sts., N.W., Washington 25, D. C. Mr. Charles Gardner, Jr., Executive Secretary to Senator Francis Case of South Dakota, is serving the Committee as part-time Executive Secretary until a permanent appointment is made.

As one of its first acts of business the Committee issued the following statement:

This Committee has been given the job of finding out whether the U. S. Government should "experiment with, engage in, or regulate activities designed to control weather conditions."

Before making its recommendations, the Committee will have to determine, as best it can, what effect weather control activities, including rain-making, have had, or may have, on the weather.

Because of the controversy surrounding this subject, the Committee wishes now to enunciate several principles which will guide it in its study.

First, the Committee will base its conclusions on facts obtained and interpreted and not on any preconceived notions. Experiments to date have suggested that weather control may eventually provide benefits to agriculture, industry and government. Without such a hint of substantial benefits, the

(*Continued on page 22*)

The Early November Sn

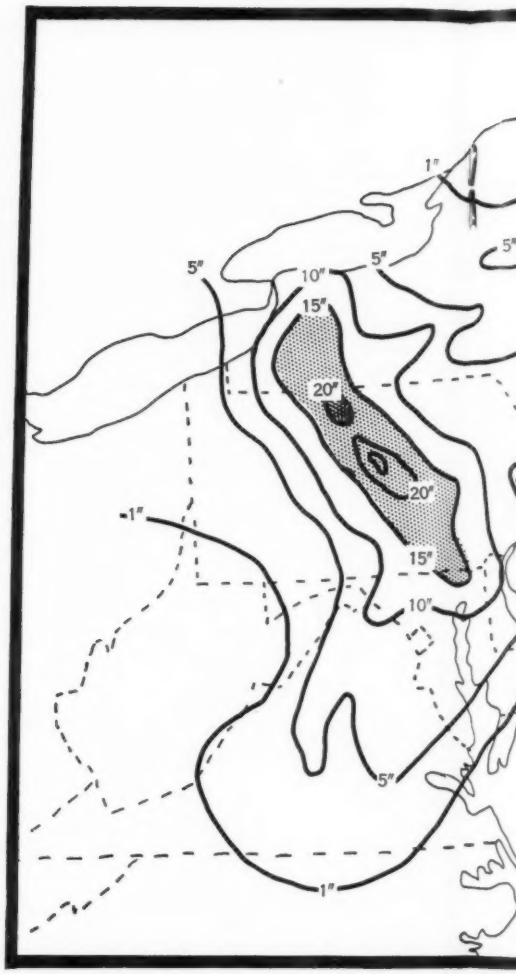
J. R. FULKS, *U. S. Weather Bu*

A REMARKABLE early season storm on 6–7 November 1953 spread a snow covering from western North Carolina northward through most of New York state and the greater part of New England. At many places it was the heaviest of record for so early in the season. Accumulations of over 15 inches were measured in a belt about 30 miles wide centered roughly along a line from York and Harrisburg in central Pennsylvania to near Buffalo, New York. The greatest amount reported was 27.5 inches at Middleburg, Snyder County, Pennsylvania, about 40 miles north-northwest of Harrisburg.

This storm will also be remembered for strong onshore coastal winds, which at places approached the strength of winds in the Great Appalachian Storm of 25 November 1950, and for abnormally high tides, which caused considerable flooding and flood damage along the New Jersey, Long Island, and New England coasts. A peak gust of 98 mph was recorded at Block Island, Rhode Island, and 78 mph at both Brookhaven, Long Island, and Long Branch, New Jersey, all early on the morning of the 7th.

Snow began early on the morning of Friday, 6 November 1953, while a low was centered off the southeast Atlantic Coast. At 0130 EST an area of rain extended from the northern Florida peninsula northward to southern Maryland and southeastern Virginia. By 0430 the precipitation from central North Carolina northward had changed to snow except at the more southern coastal areas, and the snow soon extended into inland southern New Jersey. By 0730 snow had commenced at Washington, Baltimore, and Philadelphia, though at that time the fall was still light.

Subsequently, the area of snowfall progressed both northward and toward the interior at a steady rate reaching New York City and Altoona, Pennsylvania, by noon. The fall had become moderate to heavy at many places. By Friday evening it had spread over all of eastern Pennsylvania, Connecticut, and the adjacent portion of New York state, and by the morning of the 7th covered most of New York, Pennsylvania, and New England northward as far as central Maine. Amounts in New England were light except in Connecticut and central and western portions of Massachusetts.



Total snowfall in inches on 6–7

To the south, snow continued a large part of the night of the 6–7th, even as far as northern and eastern Virginia. Some of the amounts reported on the ground on the morning of the 7th were: Richmond 3 inches, Washington 4, Baltimore 6, Harrisburg 11,

ber Snowstorm of 1953

ather Bureau, Washington, D. C.

n inches on 6–7 November 1953.

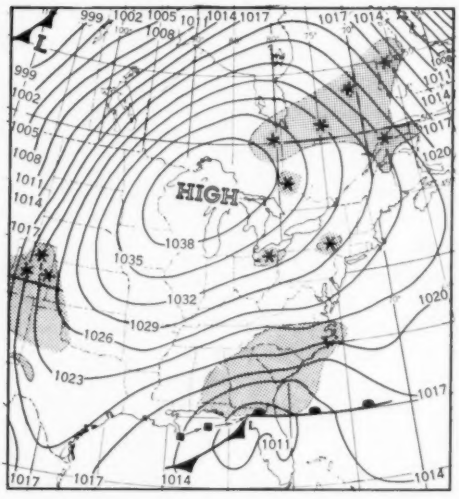
Philadelphia 8, Binghamton 7, Rochester 5, and Albany 1. In New York City, where the maximum accumulation, as measured at the downtown office of the Weather Bureau, had been three inches the evening before, the snowfall changed to rain around midnight, and the snow on the ground mostly disappeared by morning. Damage and inconvenience from the storm in the New York metropolitan area was more by flooding than from snow; extremely high tides aided by strong winds forced evacuation of several thousand homes on Long Island, Staten Island, and the North Jersey Coast.

In New England water was high along the entire coast, but the principal damage was along the Connecticut shore of Long Island Sound. High winds caused disruption of telephone and electric service at many places in Massachusetts, Connecticut, and Rhode Island. Flood and wind damage combined along the North Jersey Coast from Barnegat to Sandy Hook was estimated in the press at $6 million. In several communities shoreline properties suffered a worse beating than in either the 1950 storm or the hurricane of 1944.

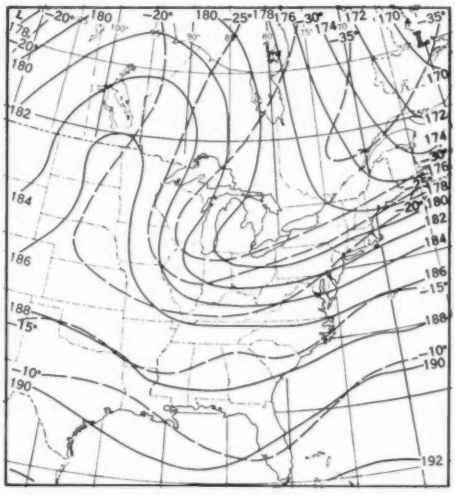
Some further comments on damage or inconvenience caused by the storm, as quoted from reports of Weather Bureau climatological section centers, are: New England (Boston): "Along the coasts the storm was the worst since that of November 1950 for combined wind and water. In general: small craft were washed ashore, roads and cellars flooded, families evacuated, seafront buildings damaged by surf. . . ." New Jersey (Trenton): "The snow drifted badly and interfered with traffic until reduced by rain. . . . Gale winds of near 70 miles per hour were registered on the coast and heavy damage was done by wind-driven waves at high tide. . . ." Pennsylvania (Harrisburg): "Highway traffic was snarled, and in many places halted by stalled and abandoned vehicles at the height of the storm. Rail traffic was behind schedule, planes were halted, river traffic slowed or halted. High winds caused 3 to 4 foot drifts. Schools were closed in the West Chester area. Four roofs were broken by weight of snow in Snyder County." New York (Albany): "There were up to two feet of snow along the southern edges of Cattaraugus and Allegany Counties . . . high tides caused an unusual amount of damage. At Poughkeepsie the tide was reported about 4 feet above normal while Albany crested about 2 feet above normal."

Synoptic conditions are illustrated in an accompanying series of maps. At 1330 EST on 5 November a low was moving into the northern Florida peninsula from the west Gulf and at the same time a new center was forming offshore to the east of the peninsula. The original low had developed on the previous day over the northwestern Gulf of Mexico and had been attended by rains along the Gulf coast. By 0130 the rains had moved eastward and northward into Georgia and the Carolinas. An important feature of the situation was the intense high centered over the northern Great Lakes region. Sea level pressures of 1040 millibars (30.71 inches) were reported in northern Wisconsin and Upper Michigan. Accompanying this high was a large area of unseasonably low temperatures. Afternoon surface readings on the 5th ranged from near freezing in northern New England to a little over 50° F in southern Virginia. Surface winds were generally north to northwest, so that the cold air was carried southward at a sufficient rate to indicate that any northward extension of the precipitation area would likely result in snow rather than rain over most of the inland Middle Atlantic and New England area. It is interesting to note that as a result of the coldness of the high, the upper trough at the 500 mb level (approximately 20,000 ft.), which extended generally from northeast to southwest, was only about 400 miles to the southeast of the surface high pressure center. The position of the upper trough is shown on the 500 mb chart for 1000, 5 November.

The trough aloft played an important part in subsequent events. It will be noted that the contour gradient through the trough, indicative of the strength of the winds, was strongest on the 5th over Illinois, weak over extreme southern Ontario, and strong again over the Gulf of St. Lawrence. This wind distribution, which had developed within the preceding 12 hours, indicated a definite trend toward the formation of a cutoff low center at the 500 mb level over lower Michigan. The isotherm pattern showed a sharp cold ridge to the rear of the trough with the amplitude of the isotherms greater than that of the contours. This was suggestive of further deepening in the same portion of the upper trough, and an indication that a definite upper low center would likely develop within the next few hours. From experience it is known that formation of a cutoff low aloft is accompanied by a slowing down of the movement of upper level systems. The 500 mb chart 24 hours later showed a well-marked upper low centered over extreme southeastern Ohio.



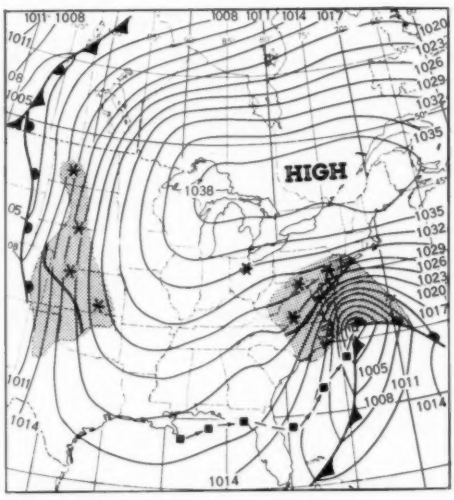
Surface Chart, 1330 EST, 5 November 1953.



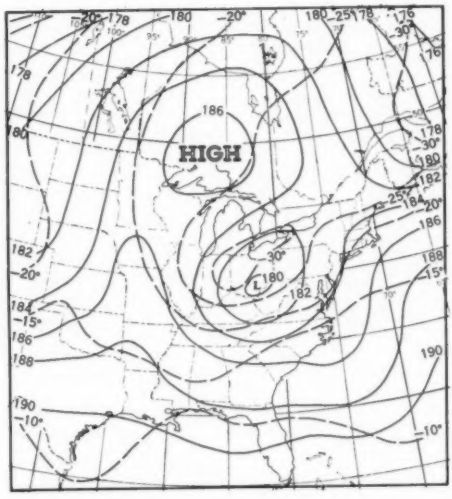
500 mb Chart, 1000 EST, 5 November 1953.

The upper-air chart for 1000, 5 November, shows also a weak trough aloft over the west Gulf, which was directly associated with the surface low, but was not in line with the trough to the north. As the surface low developed and moved northward off the Atlantic Coast, the southwestern end of the northern upper trough moved southward and eastward around the upper low until on the afternoon of the 6th it was in line with the southern trough, which was then located off the Atlantic Coast. On the 500 mb chart for 2200 of the 6th this trough extended east-southeastward from the upper low center across West Virginia and Virginia and was much sharper than shown 12 hours previously. The trough then moved rapidly northward and at 1000 of the 7th extended from northern West Virginia through Maine. The northward movement of the upper trough seems to have been immediately preceded by intensification of the precipitation; for example, at Atlantic City, New Jersey, a total of 2.62 inches of rain fell between 0100 and 0400 EST of the 7th, of which 1.10 inches was between 0300 and 0400. This was also approximately the same time as the closest passage of the surface storm center some 70 miles offshore. At Washington, D. C., the heaviest snowfall of the storm was between 2200 and 2300 of the 6th, coinciding with the approach of the upper-level trough from the south.

Movement and intensification of the surface storm are indicated on the charts for 1330 of the 6th and 7th. On the 6th the center had moved northward to a point off Hatteras and had deepened markedly. In addition, high pressure had extended rapidly from southern Quebec eastward. The combination of a rise in pressure to the north and a fall to the south was accompanied by a development of strong east to northeast surface winds north of the low center, as shown by the pressure gradients at noon of the 6th. A full explanation of the rapid eastward building of the surface high, a feature very important in the behavior and effect of the coastal storm, involves factors too complicated for discussion here; however, it occurred in the wake of a deep northeastward moving low, which at noon of the 5th was centered south of Greenland and east of Labrador. The effect of the upper-level steering suggests that the surface low should have moved northeastward from northern Florida, rather than along the more northerly path it actually followed. An explanation appears in the development of the 500 mb low and its near stagnation for some 36 hours in a small area of southeastern Ohio, northern West Virginia, and southwestern Pennsylvania. This devel-



Surface Chart, 1330 EST, 6 November 1953.

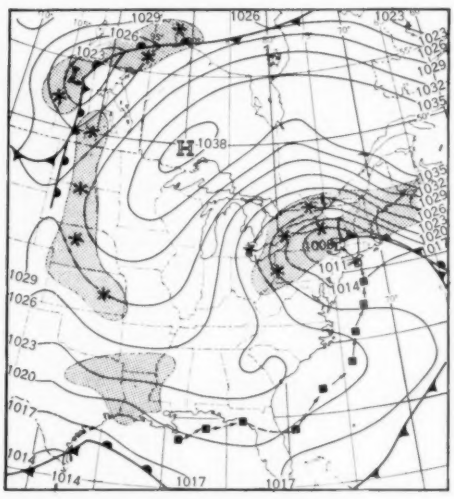


500 mb Chart, 1000 EST, 6 November 1953.

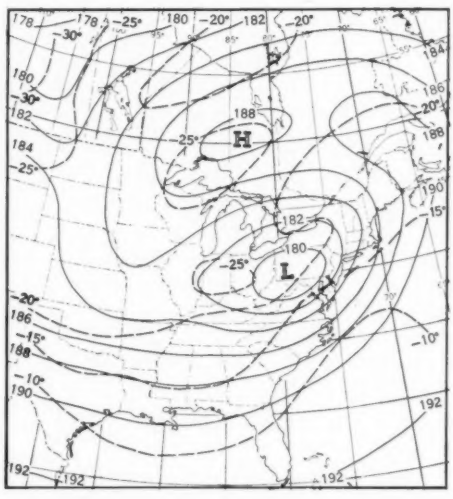
opment and stagnation meant a progressive change of the upper-level steering effect until, as shown by comparison of the charts for 7 November, the surface low center was within the closed upper-level circulation of the upper low. By noon of the 7th the surface low had already moved inland in response to this steering effect; after that time it continued a generally northwestward movement across New York state into southern Ontario.

A secondary factor in the movement of the storm center was the relative warmth of water off the coast during the autumn season. When cold air covers the land areas adjacent to the Atlantic Coast, the cold mass flowing over the water is warmed rapidly so that a sharp temperature gradient is maintained within one or two hundred miles off the coast. Since extra-tropical surface lows tend, in general, to move along a band of strong temperature gradient, the offshore temperature gradient that existed on 6–7 November was a factor favorable for movement roughly parallel to the coast line. Even over the ocean, however, temperatures were colder to the north, and it does not follow that movement of the low would be in the more northerly direction. A surface low tends to move more and more into colder air as it develops, but it does this only slowly. While the 6–7 November storm moved into a region occupied previously by much colder air, it did so only as warmer air was carried northward ahead of the developing storm. It is, therefore, more logical to look upon the combined steering effect of conditions at all levels aloft, including the lower level easterly flow that developed great strength by reason of high pressure to the north, as the primary factor in the unusual movement of the surface cyclone.

Studies of Middle Atlantic states snowstorms by the Weather Bureau, covering a period of more than 50 years, have not revealed any others which behaved in a similar manner. This storm had, however, some features in common with the great storm of 25 November 1950, though the low center in that case was entirely inland, and perhaps more so with a snowstorm of 16–17 November 1920. It also bears some resemblance to a storm on 23–25 October 1923 that was studied by J. Bjerknes and M. A. Giblett (see *Monthly Weather Review*, November, 1924), though the latter storm was accompanied by rain and not snow and moved inland farther south, near the mouth of Chesapeake Bay.



Surface Chart, 1330 EST, 7 November 1953.



500 mb Chart, 1000 EST, 7 November 1953.

Report of the Advisory Committee on Weather Services

The following are excerpts from the introductory part of the Committee's report. Complete copies are on file at all first-order Weather Bureau stations. It is understood that individuals may secure copies through their Congressmen.

THE Department of Commerce Advisory Committee for Weather Services was appointed in May, 1953, by Honorable Robert B. Murray, Jr., Under Secretary of Commerce for Transportation. It was charged with a general review and evaluation of civil weather matters, especially those concerning the Weather Bureau.

[A list of the Committee members was published in *Weatherwise,* August 1953.] At the initial meeting of the Committee in June, it was decided that, wherever possible, the Committee would act in concert throughout its history. Each member of the Committee is a professional meteorologist, with an average experience in the field of over twenty years.

The Committee has held six meetings between June and November, each one lasting from two days to two weeks. The first step was to obtain a general review from the Chief of the Weather Bureau and his staff of their entire operations. Requests were then made by the Committee for detailed information covering all phases of administrative and technical work of the Bureau. This material was promptly and completely supplied and the Committee has had excellent cooperation from all levels of the Weather Bureau.

The Committee has interviewed many prominent users of weather service, such as farmers, public utilities, scientists, private meteorologists, and representatives of the Armed Forces, and other government agencies.

Weather Bureau personnel and principal users of weather information were interviewed either by the entire Committee or by task forces at Los Angeles, Santa Barbara, San Francisco, Portland, Medford, Chicago, Kansas City, Fort Worth, New Orleans, Atlanta, Miami, New York, Washington, D. C., Salt Lake City, Baltimore, St. Louis, and Boston. All regional offices were visited with the exception of Alaska, and all regional directors, with the same exception, have been interviewed as well as many line employees, including observers and forecasters.

The Committee is keenly aware of the many difficulties and problems which have beset the Weather Bureau during the last two decades. Over and above the routine difficulties experienced in the administration of Civil Service procedures by all government agencies, the Weather Bureau has had to adjust its course to conform to an extremely rapid growth in the science of meteorology, as well as the emergence of a private practice in meteorology. Due to these unusually rapid developments the Weather Bureau has had to do its best to train the existing personnel and at the same time recruit new personnel who had received formal training in the universities. This change has created a certain amount of personnel difficulties and has made it hard for them to develop the scientific stature which the organization should have.

Throughout the activities of this Committee, budget difficulties of the Weather Bureau have been encountered at every turn. It is only fair to state that part of the recommendations contained in this report cover deficiencies recognized by Bureau officials and could have been remedied if sufficient appropriations had been available.

We should like to make it clear that we believe the present Chief of the Bureau has served with a devotion to duty, and conscientious effort, seldom found in any organization.

It is inevitable in a report of this kind that deficiencies of the organization will be emphasized, while the adequacies, of which the Weather Bureau has many, are likely to be subordinated. This report should be read with this in mind.

We believe that this report reflects the general opinion of the profession. The conclusions and recommendations are our own however, and have the unanimous concurrence of the Committee.

Weather is the Nation's Business

The organic act of 1890 under which the Weather Bureau still functions was written at a time long before the present developments and applications of the science to business and industry could have been envisioned. It is necessary, therefore, that a redefinition of functions be made to recognize the changes since that time. In 1953 we find professional meteorologists working in many areas outside of the Weather Bureau. In the chemical industry they assist in plant design, air pollution, production and marketing problems. In aviation leading airlines have large meteorological staffs to promote safety, efficiency, and passenger comfort in their operations. In the petroleum industry meteorologists are necessary if offshore drilling is to be successful and for other types of plant protection. Specialized meteorology must be utilized if hydroelectric plants are to be operated efficiently. In the gas industry meteorologists aid in planning the production of wells and in the regulation of supplies. And in many, many other industries and businesses where the meteorological interest may not be sufficient for full-time staff meteorologists, the consulting meteorologist aids by being called in on specific problems. Business and industry are beginning to recognize that substantial savings, increased profits, and therefore lower prices to the public can be effected by considering the weather in their day-to-day operations. In this era of a complex industrial society, and concentration of population in large cities, weather vitally affects us all. Today, "Weather *Is* the Nation's Business."

The Weather Bureau, still operating under the organic act of 1890 and subsequent amendments, has attempted to meet the changing needs indicated, not always with desirable results. In a highly commendable effort to do all things for all men, the Weather Bureau sometimes loses sight of the point where government should stop in providing specialized service. We think of the Weather Bureau and its relation to the new profession of private meteorology in the same way as we think of the United States Public Health Service in its relation to medical practitioners. We would admit that epidemics are a concern of the government health service but individual illnesses are the province of the private practitioner. Similarly, the issuance of severe storm warnings endangering life or widespread damage to property are, and should remain, the function of government but special services to industries to effect economies in their operation must be the province of the private practitioner.

It is for these reasons and because of the change of our life in the past sixty years from a rural agricultural economy to a highly integrated technical society that a redefinition of the functions of the national weather service must be made. While all of the recommendations of this report can be implemented under the existing organic act, we feel it is desirable that a study be made to determine whether the basic law should be revised. The following are the Committee's recommendations as to the functions of the Weather Bureau under such a revision of the law.

Functions of the National Weather Service

1. To observe, measure, record, collect, and disseminate reports of the weather in the United States, its territories and possessions and to make these data available to all users.

2. To participate in the development of an international basic meteorological network including the establishment and operation of reporting stations on the high seas, in polar regions, and in foreign countries in cooperation with other governmental agencies of the United States and the meteorological services of such foreign nations.

3. To issue severe storm warnings, cold wave warnings, and flood warnings to the general public where extensive danger to life or property is involved, and to other governmental agencies, and to ships at sea and in the coastal and inland waters.

4. To prepare a simple, high quality general forecast of the probable weather for the general public and to encourage the widest dissemination of this forecast.

5. To encourage and assist the unrestricted development of the profession of meteorology to meet the special needs of industry, business, and agricultural groups.

6. To make such special weather observations, reports, and forecasts as are required for safety of aerial and marine navigation in the United States, its territories and posses-

sions and to provide such special weather information as is required by individual farmers.

7. To promote and foster research in meteorology by the use of private and governmental research facilities and to support and encourage the dissemination of the results of such research.

8. To coordinate the meteorological requirements of the United States in order to maintain standards of quality in observations, promote efficient use of facilities, and avoid duplication in services unless such duplication is in the public interest.

9. To collect and store foreign weather reports.

Principal Recommendations and Conclusions

1. The Weather Bureau at present is highly centralized and should be reorganized with a delegation of both administrative and technical responsibility downwards.

2. Several of the high level assistants of the Bureau have reached, or are approaching, retirement age. Adequate replacements should be selected, trained and given necessary authority and responsibility as rapidly as it is possible to do so.

3. The headquarters in Washington should be a small policy-making staff with all operating functions outside of the Washington area.

4. The personnel policies of the Bureau should provide for a continued influx of young professional meteorologists.

5. The Weather Bureau should assume certain basic duties which are presently being performed by other agencies, notably the military. (In order to assume these duties it will be necessary to increase the budget of the Weather Bureau. However, this will be more than offset by the decrease in the military budget effected thereby.)

6. An aggressive, imaginative "can-do" research program should be set up and undertaken with a budget adequate for its performance.

7. The attitude of the Weather Bureau toward the development of the new profession of private meteorology should be to assist actively the free growth and development of this profession.

8. The forecasting organization should be strengthened by the addition of capable experienced forecasters at both the staff and regional levels. The actual forecasts should be decentralized.

9. The climatological program should be vigorously renewed.

With these functions and attitudes as the basis of operation of the Weather Bureau, the Department of Commerce should strongly support the Bureau in its representations for the necessary funds to carry them through.

How Can Savings Be Effected?

We have been aware of the need for effecting budget savings when compatible with acceptable efficiency. This has been difficult because as will be seen this is one government organization which has been frugal to the point of diminishing returns. Despite this situation and our belief that this service should be increased in efficiency as the first requirement, it is believed that implementation of the following recommendations will result in an over-all decrease in budget for the nation's weather service although that of the Weather Bureau must be increased.

1. The return of certain research, climatological and observing functions from the Armed Forces to the Weather Bureau.

2. Arrangements should be made to utilize any appropriate semi-permanent Army GMD-1A installations to replace current observation stations. There is no reason why both functions cannot be served.

3. Fewer major forecast centers. (Reduction from 15 to 5.)

4. Increased efficiency by decentralization.

5. The continued combination of certain CAA INSAC stations with Weather Bureau observing stations. The utilization of certain low density towers as observing stations when equipped with remote reading instruments.

6. As the growth of private meteorology is encouraged and replaces certain specialized Weather Bureau services to industry, some saving of personnel can be effected. (Reduction and eventual elimination of special services.)

7. Development of a cheaper means of obtaining upper-air data over the oceans.

8. The encouragement of state and local governments to participate in programs such as hydrologic observations and the preparation of local climatological summaries.

9. Adequate charges for publications, especially climatological bulletins.

Weatherwatch

Pacific Air Dominates the Early Winter

DAVID M. LUDLUM, *Editor*

FAST westerly flow at upper levels of the atmosphere characterized the circulation pattern across the United States during the early winter season of 1953–54. This was much the same situation as occurred during the previous winter, which was the second mildest on record for the nation as a whole. Both November and December averaged warmer than normal in 1953, to make a start toward another mild winter, bringing despair to winter sports fans in the East who have had little help from Old Man Winter since 1947–48. Boston had no measurable snowfall in either November or December 1953!

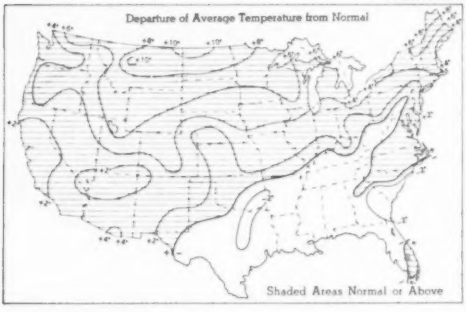
Meteorologists describe a flow pattern when strong westerly winds predominate as high index, meaning that the speed and persistency of westerly winds flowing along the lines of latitude are greater than normal. Under these circumstances the fast flow across the Pacific Ocean rushes mild, moist air masses into the Pacific Coast states, across the Rockies, and into the great central valleys, to dominate weather conditions all the way to the Atlantic. Polar air is contained in the sub-Arctic, and Gulf air is prevented from moving northward with any persistency, so great is the strength of the westerly flow. The temperature pattern across the nation, under westerly control, usually divides into three zonal areas: in the North much above normal averages are experienced; in central sections readings are above normal; while the South from Texas to the Atlantic has normal or slightly below normal temperature conditions. Thus, with a gradual temperature gradient from north to south, air masses do not possess marked contrasts, storm development is at a minimum for the season, and spectacular weather events are generally lacking.

The winter seasons of 1951–52 and 1952–53 were dominated by a high index of westerly flow, as a whole, with mild conditions prevailing over northern and central sections and near normal conditions in the South. Low index conditions, when westerly control of the flow patterns is lacking, have tended to occur in recent years in the spring and fall seasons. Thus, talk about the passing of the "old-fashioned winter" is heard on every corner. Long range forecasters, however, warn that low index conditions in winter will return, and then we may be reading books such as the recent, *Our Changing Climate*, in reverse.

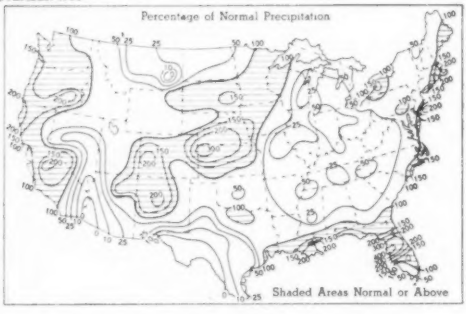
NOVEMBER CIRCULATION—During the first days of November there was little north-south extension of the waves in the fast-moving westerly flow across the country. A small trough lay off the Atlantic Coast, a small ridge just east of the Rockies, and a minor trough off the Pacific Coast. All storm tracks during the first two weeks of November were through southern or central Canada with the exception of one Gulf low, which developed into the severe snowstorm and gale in the Northeast on 6–7 November. This, however, was a singular case, and no other occasion of storm development followed in the Gulf or along the Atlantic Coast until after the 15th.

The month opened with two Alberta type lows, typical of high index conditions, moving eastward just north of the Canadian border. After the second, a high pressure cell rapidly built up strength over the Upper Lakes to 1041 mb (30.74″), and the first zero readings east of the Rockies were registered on the 5th. At the same time a small low pressure area took shape in the Gulf of Mexico,

MONTH OF NOVEMBER 1953



Departure of Mean Temperature from Normal in degrees Fahrenheit. USWB Chart.



Percentage of Normal Precipitation. USWB Chart.

moved eastward across northern Florida, and appeared headed for the central Atlantic. The full story of what happened to this innocuous looking low is described on pages 12–16.

The low center, as it curved northwestward across the middle Atlantic states, joined with a closed circulation aloft, always a sign that the movement of the weather elements is slowing down. The deep low center dominated the circulation over the eastern half of the country until the 9th with a western ridge-eastern trough pattern. To the west of the ridge, the Aleutian low was very active, sending several offshoots eastwards as Alberta type lows. By the 13th a system moved southward and entered the northern California coast, giving substantial rainfall amounts as far south as San Diego, the only heavy precipitation of the current fall-winter season there. Now the flow pattern was reversed, an eastern ridge-western trough regime was established, and with anticyclonic conditions dominating the central valleys a very dry mid-November week occurred in all sections except the immediate coastal areas.

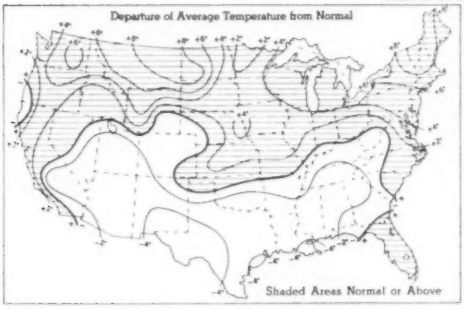
After the 15th a gradual shift in the pressure pattern distribution was noted throughout the northern hemisphere, and a shift in storm tracks followed in the United States. A trough was now orientated through the Mississippi Valley with ridges flanking to the east and the west. To the north over Canada low pressure persisted with very deep lows breaking away from the active Aleutian center and moving rapidly eastward to the Icelandic-Greenland low. These systems trailed fronts southward over the United States, and induced storm generation over the Southwest; two lows moved eastward and then northeastward from Nevada and gave the Middle West two periods of active weather on the 18–20th and the 21–22nd. Widespread snow and rain all the way to the Atlantic Coast broke the threatened renewal of the drought over much of the eastern half of the country.

DECEMBER CIRCULATION—The flow pattern in December continued along the same general lines as during November, although important changes were in progress toward the close of the month. Pressure averaged below normal over central and northern Canada and above normal in southern United States, a typical high index condition. There was no important anticyclonic activity in the Yukon of Canada, and the Bermuda high was not prominent in the Atlantic. It was another month of containment of polar air masses in the Arctic and of Gulf air masses in tropical regions, leaving the way open for maritime influences from the broad Pacific Ocean to dominate.

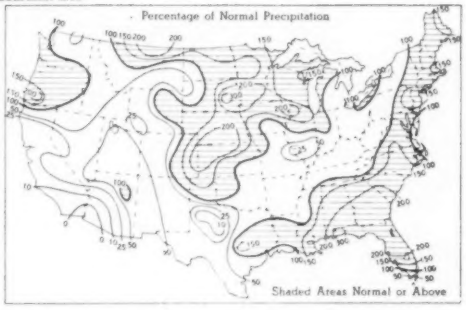
The mean pressure maps for December show a trough continuing in the Mississippi Valley with ridges off each coastline. The ridge off southern California gained strength as the month progressed, and a polar low moved into northeast Canada and deepened. These, however, were later developments, and were not of sufficient strength to check the westerly influences in December, so warm weather continued along the northern border states, except for the third week when a cold outbreak sent the mercury tumbling to −29° at Bemidji, Minn., on the 15th. It averaged a very warm December in all northern regions: there were monthly plus departures of 6 degrees in Washington, 8 in Montana-North Dakota, and 8 in northern New York-New England. As mentioned previously, Pacific air flow usually means below normal readings in the Deep South. It was coldest along the Gulf Coast and in southwest Texas, where minus 4 degree departures from normal were registered. The resort areas of Florida had several cold spells but averaged out just about normal.

The precipitation pattern over the country exhibited great contrast in accordance with proximity to the active storm tracks. Rainfall was heavy on the northern Pacific Coast as the maritime air masses moved inland, and moisture was also carried to the northern Rockies and Great Plains. It was also moist in a long band from Louisiana northeastward to Maine, as both Gulf and Atlantic sources of moisture were tapped by eastward-moving troughs. But there was a wide band of decidedly lower than normal precipitation from west Texas, through the middle Mississippi Valley, to the northern reaches of the Ohio Valley. This band lay too

MONTH OF DECEMBER 1953



Departure of Mean Temperature from Normal in degrees Fahrenheit. USWB Chart.



Percentage of Normal Precipitation. USWB Chart.

far to the southeast to benefit from the Pacific moisture carried eastward by North Pacific lows and too far away from the Gulf to receive moisture replenishment from that source. In the far Southwest, also, it was very dry, especially in western Arizona and southern California where the effects of the ridge in the eastern Pacific Ocean were dominate. A large area received less than 25 per cent of the normal December rainfall, and in the important Imperial Valley agricultural section no rain fell.

FLORIDA FREEZE—The one important polar outbreak of the month penetrated into the Deep South in the wake of the storm of the 14–15th, which moved northeastward across the Lower Lakes. Upper-air flow was straight from the northwest all the way to Florida, and the freezing level at 10,000 feet was above the central peninsula. Mr. Warren O. Johnson, of the U. S. Weather Bureau at Lakeland, has reported to Weatherwise: "A rather severe freeze, as far as tender crops are concerned, occurred from 15–19 December. Minimum temperatures were freezing and below with frost on all dates in most of the farming areas. Temperatures from 26–30°, with a few low spots down to 22°, prevailed in north Florida; and readings from 30–36°, with low spots down to 27°, in central Florida; from 30–35° in the Everglades, with cold locations down to 27°. The lower East Coast farming areas experienced readings from 34–38°, with a few locations down to 32°. The West Coast district faired better than any other section with readings generally from 34–38°, and few places down to 32–33°. Frost was scattered and generally light during this cold spell except on 16 December, when extremely heavy frost occurred in almost all the farming areas of the state, but was only light along the lower East Coast and in the West Coast district. Some growers remarked that the frost on the 16th was almost like a snow.

"A secondary cold spell occurred on 26–27 December when temperatures near or slightly below freezing and scattered light frost occurred as far south as the Everglades area. Frost damage during the month was rather heavy to such crops as beans, corn, cucumbers, and other tender crops. The greatest damage occurring in the Everglades was on the 16th. Spotted damage to unprotected tender crops and ornamentals in other sections of central and southern Florida occurred during this cold spell with remaining tender truck in northern sections killed and considerable damage to unprotected ornamentals and slight damage to hardy truck. The cold weather and frost of 26–27 December did very little additional damage except for retarding growth and lowering the quality of most remaining tender crops.

"Advanced warning caused many growers to force pick large acreages of marketable tender crops. Other regular means of frost protection saved additional vegetable crops and general widespread protective methods accounted for saving of most home and nursery ornamentals. The cold weather was generally beneficial to citrus.

Advisory Committee

(*Continued from page 11*)

Congress would most likely not have created this Committee. However, the Committee will not now proceed under the assumption that weather control, including rain-making, does "work" or does not "work." It will aim to examine all of the evidence with scholarly care and scientific impartiality.

Second, the Committee recognizes the need for additional basic research dealing with processes related to rain, snow and cloud phenomena. There is also a need to develop ways and means of providing methods for reliable evaluation of weather control activities. The Committee will encourage such research in industry, at our universities and throughout government.

Third, the Committee will welcome, and will solicit, the information possessed by and the opinions held by all individuals and groups having an interest in the field of weather control. It will carefully consider all facts and opinions pertinent to its study.

Fourth, the Committee will not act in any way prejudicial to responsible individuals and concerns attempting to modify the weather.

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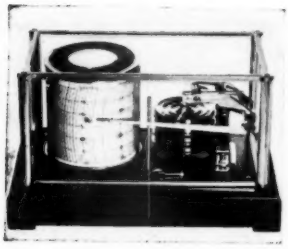

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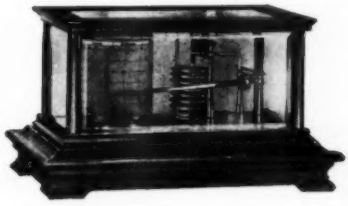

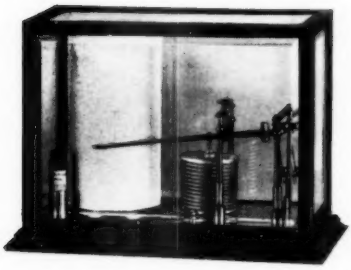

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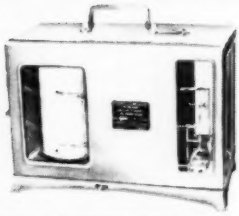

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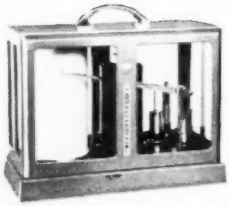

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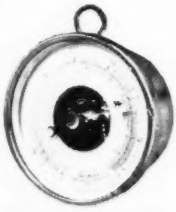

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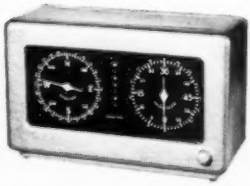

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